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WindScanner systems

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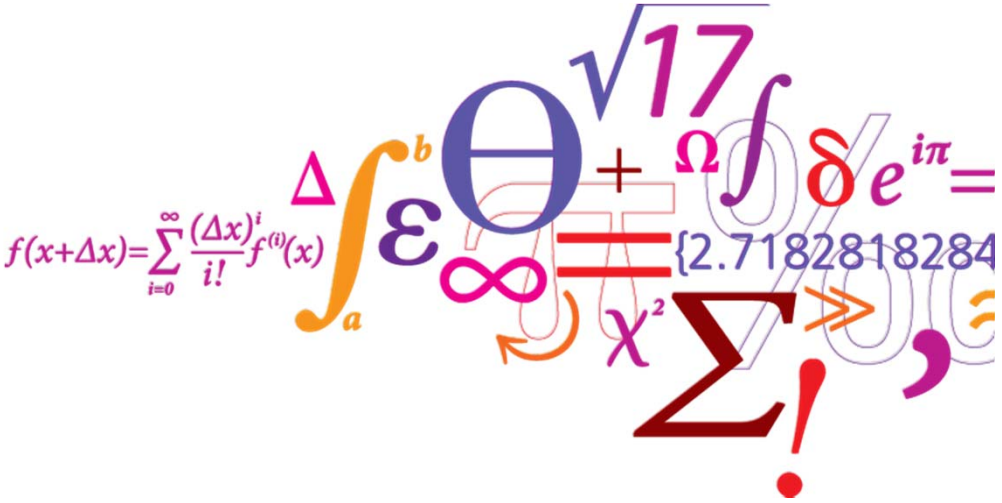
WindScanner systems

Nikola Vasiljević

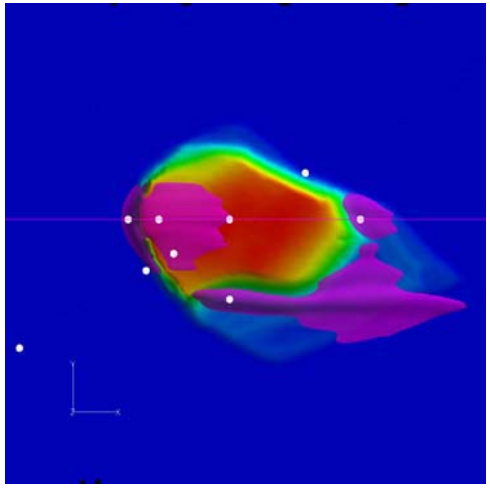


IRPWind conference, Amsterdam
25/09/2014

DTU Wind Energy
Department of Wind Energy

Why do we measure wind velocity?

- Performing experiments
- Establish confidence in CFD results
- Test turbulence models used in CFD
- Improving the theory
- **Basis for the advancement of our understanding of the atmospheric flows**



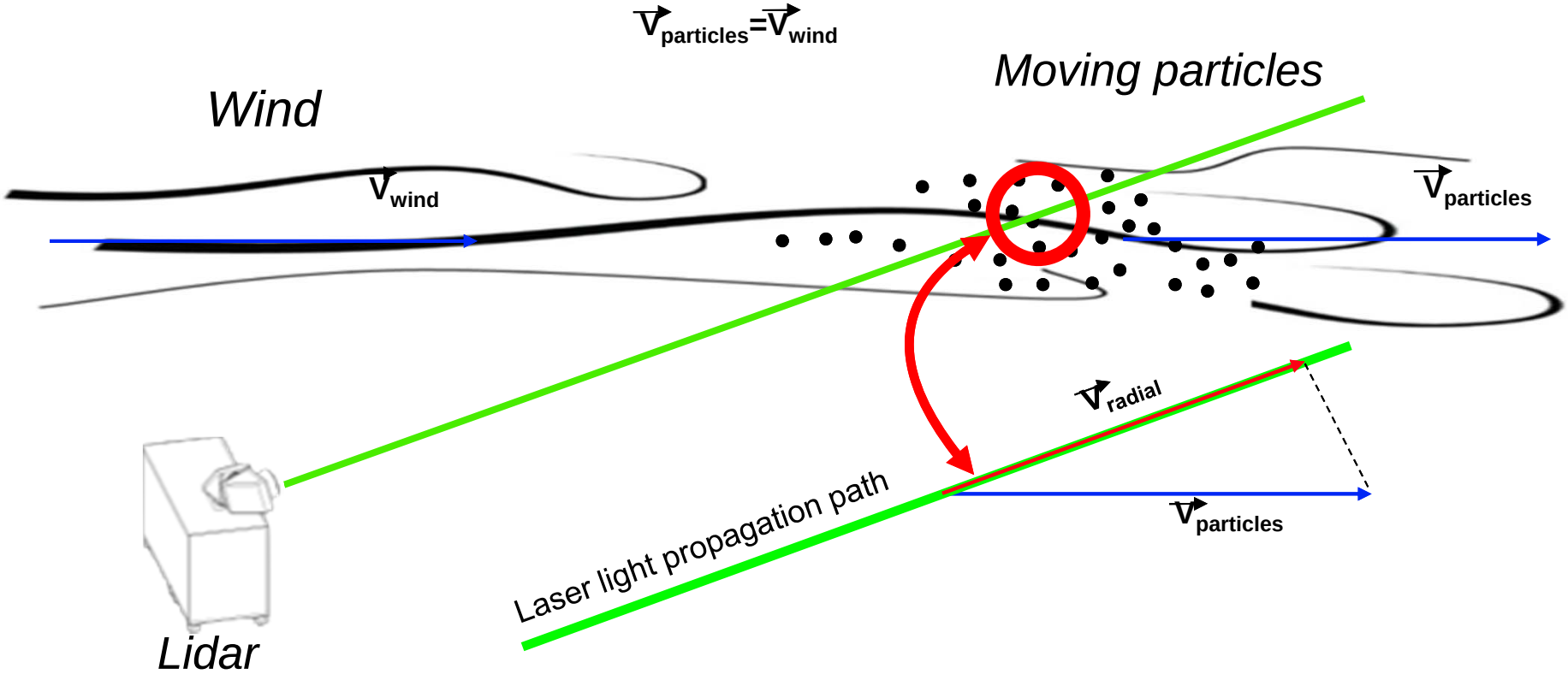
Necessity for in-situ measurement alternatives

- Tall masts are expensive
- Experiments at large scales are economically challenging
- Costs slow down the pace of the progress
- We need cost-effective and accurate alternatives to tall masts
- The most promising alternatives are **coherent Doppler lidars**

Offshore met masts	Costs	Max. height
FINO1	19 M€	100 m
Commercial met. mast	7-9 M€	100 m
Swimming met. mast	2-4 M€	60-80 m

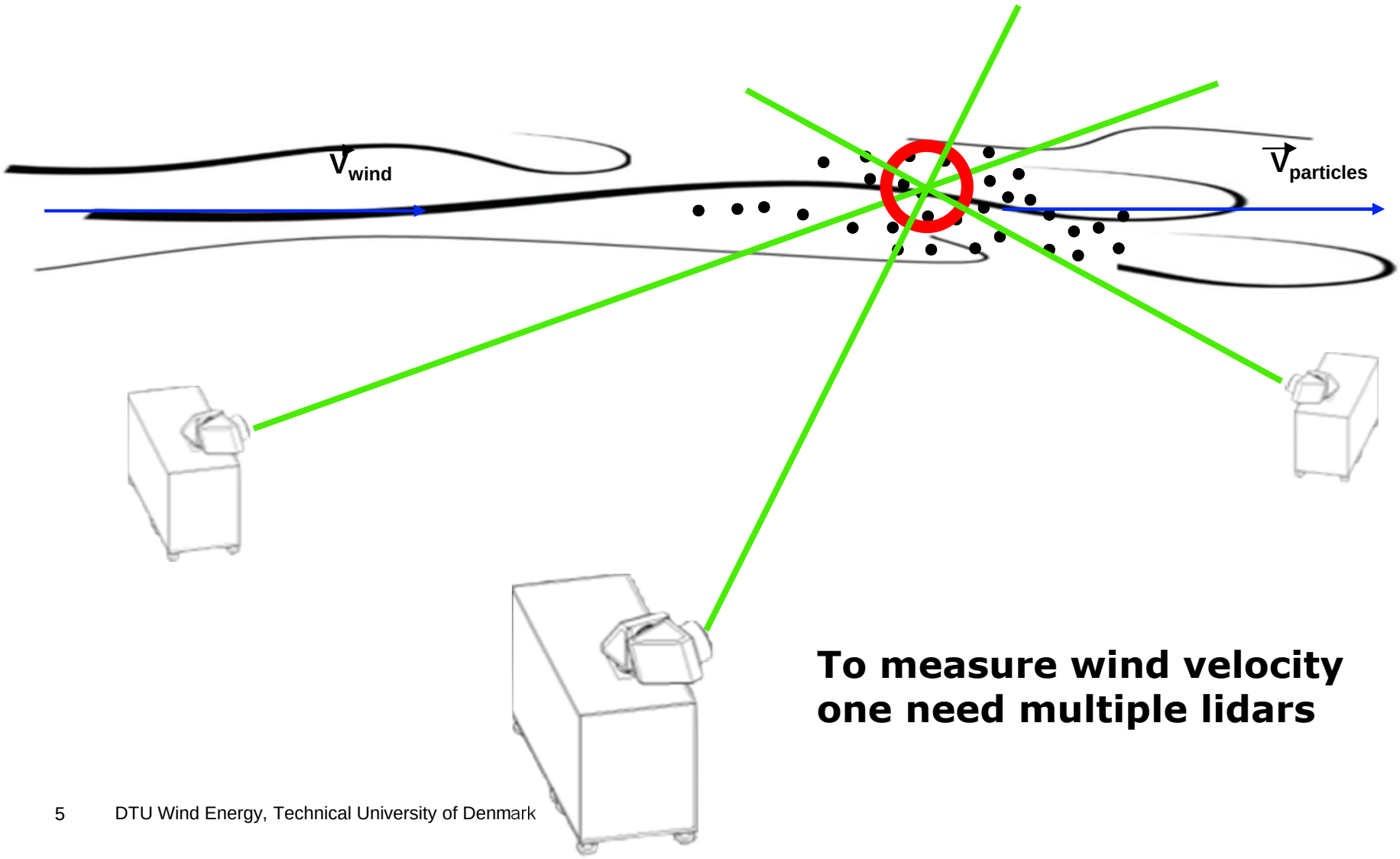
Source: Gerrit Wolken-Möhlmann and Julia Gottschall, ***Floating lidars***, DTU Risø Campus, Roskilde, Denmark, March 21st, 2013 / MARINET short course

Lidar measurements background



Single lidar measure only radial velocity

Lidar measurements background

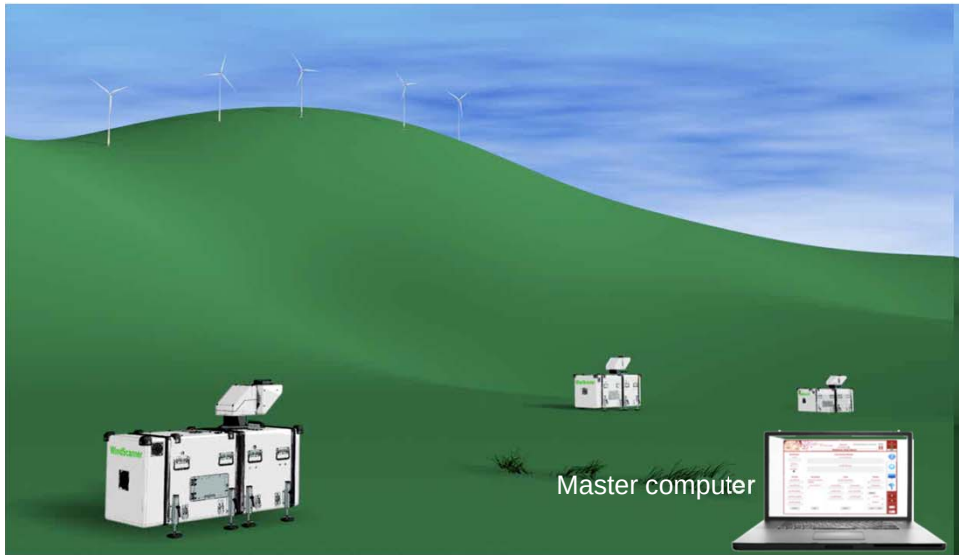


To measure wind velocity one need multiple lidars

WindScanner.DK

- In 2007, DTU Wind Energy, at that time Risø DTU, presented an ambitious idea about the development of the unified measurement systems, known as windscanner systems, which consist of three time-space synchronized scanning coherent Doppler lidars (i.e. WindScanners), specialized for detailed remote measurements of real-time wind velocity fields

Long-range WindScanner system



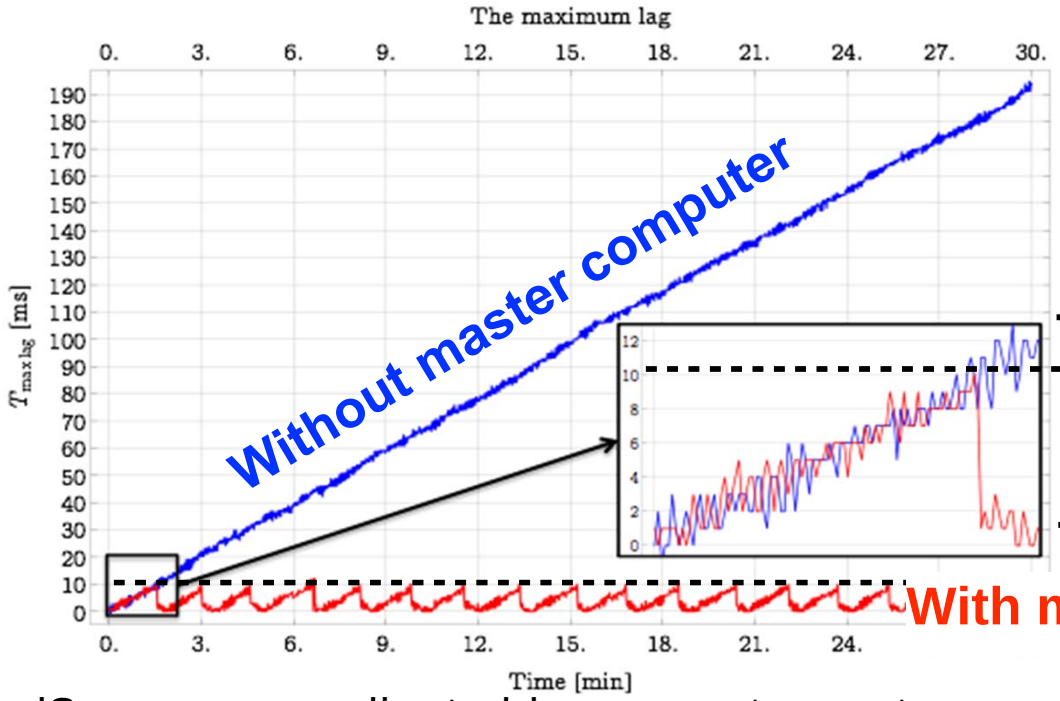
Short-range WindScanner system

WindScanners

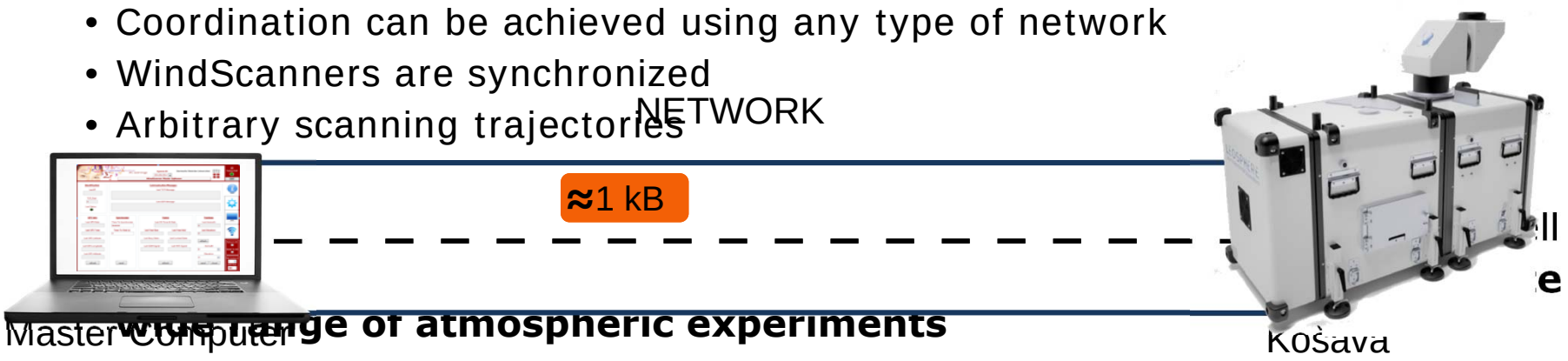
WindScanners specs

WindScanner	Short-Range	Long-Range
Laser type	Continuous wave	Pulsed
Range	10 - 200 m	25 - 8000 m
Maximum measurement rate	400 Hz	10 Hz
Simultaneous measurements	1	500
Dual axis scanner head	Double prism based	Triple or Dual mirror based
Mechanical rotation	Belt driven	Gear-box driven
Rotation	Endless	Endless
Atmospheric coverage	Cone with a full opening angle of 120°	Hemisphere
Maximum rotational speed	$2880°/s$	$50°/s$
Weight	120 kg	150 kg

Long-range WindScanner system



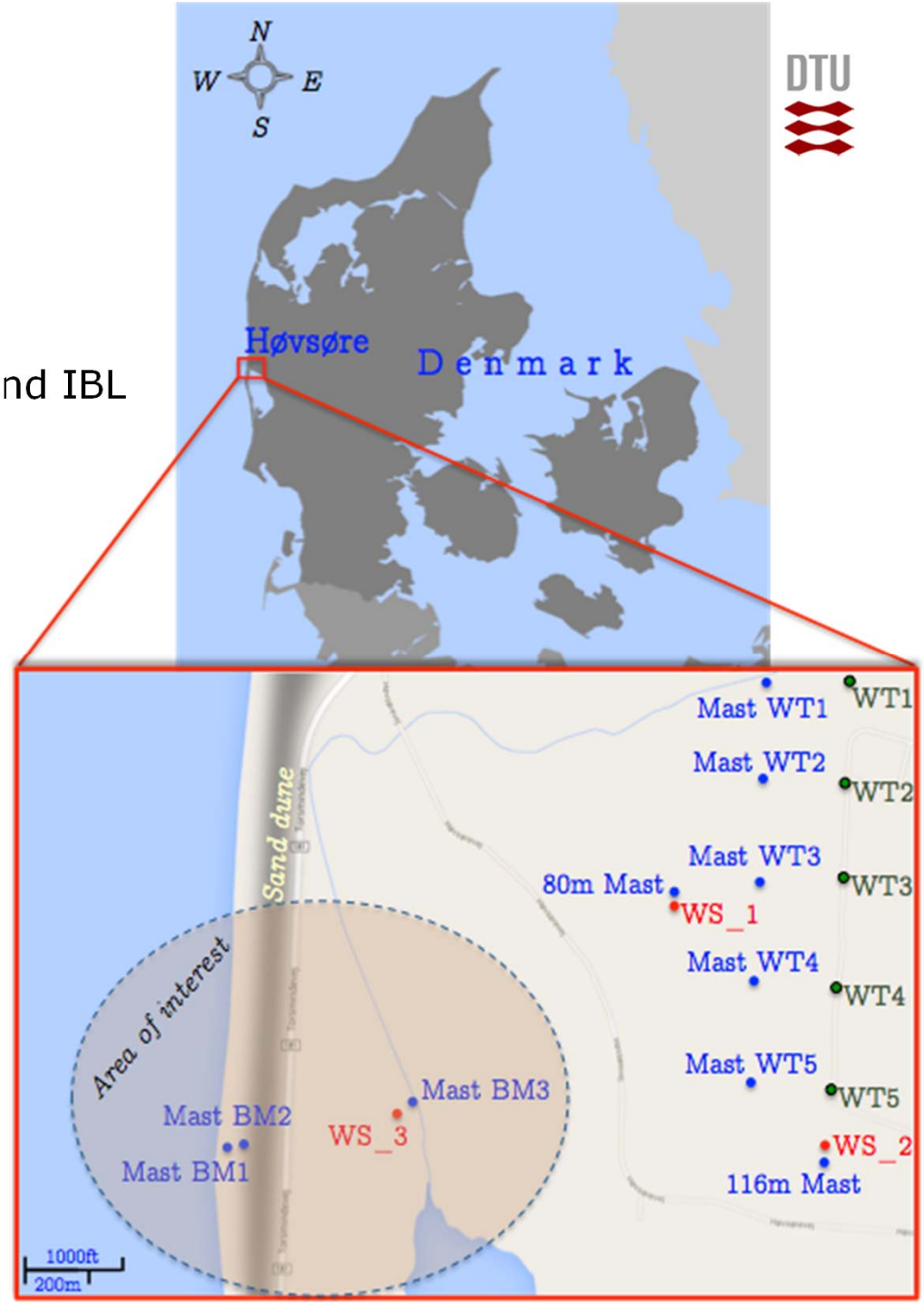
- WindScanners coordinated by a remote master computer
- Coordination can be achieved using any type of network
- WindScanners are synchronized
- Arbitrary scanning trajectories



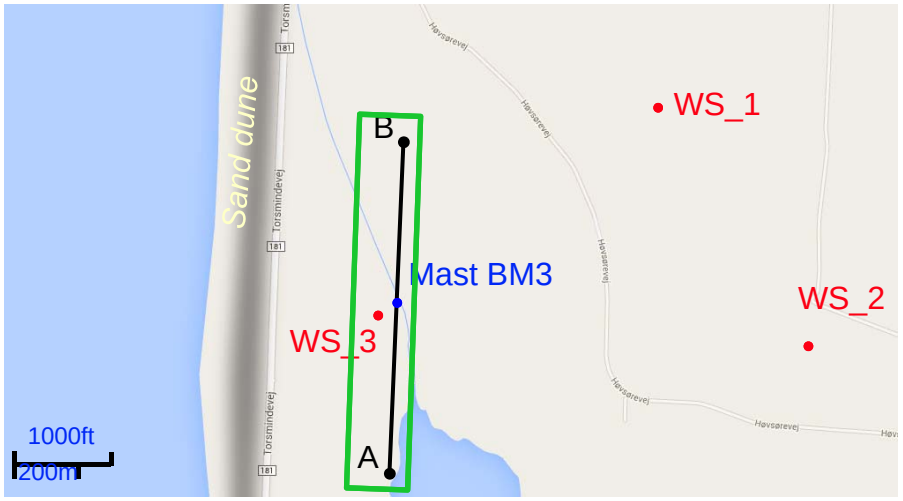
Wide range of atmospheric experiments

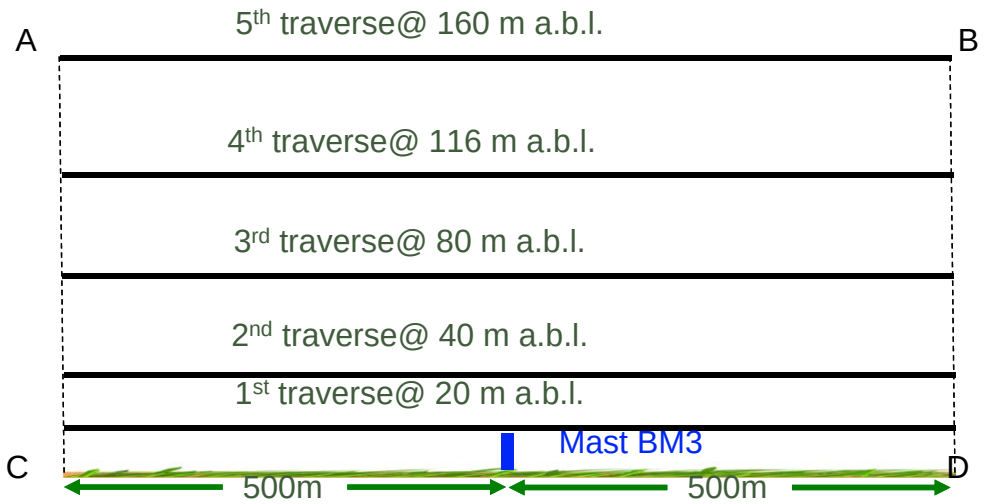
IBL WiSH

- June 2013
- Investigation of changes of sea-land IBL

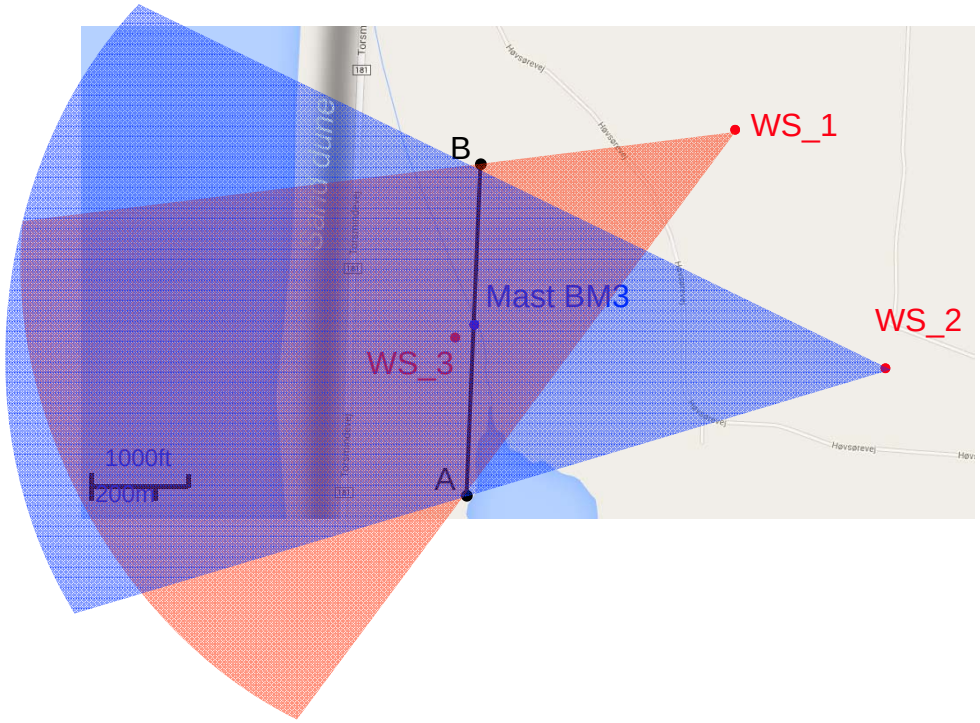


IBL WiSH experiment layout

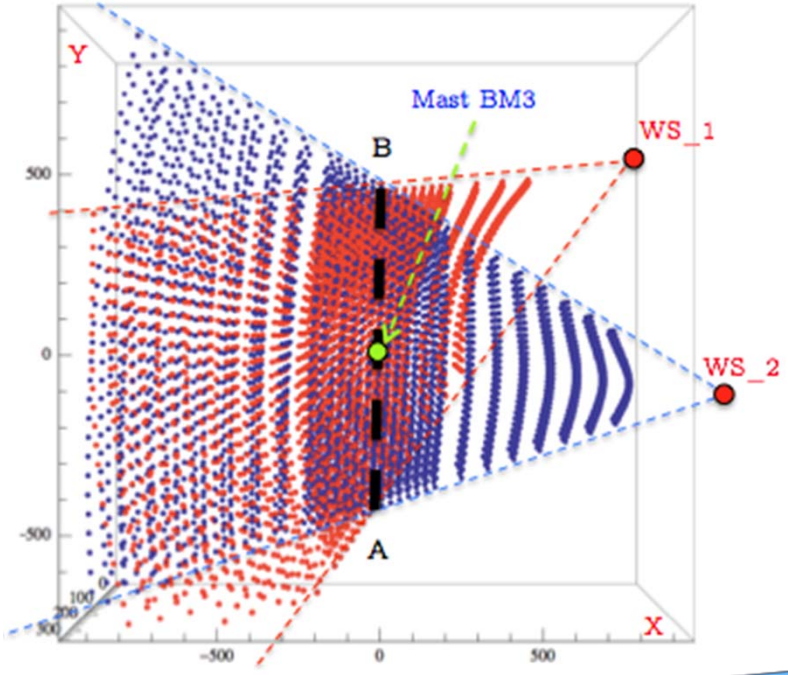


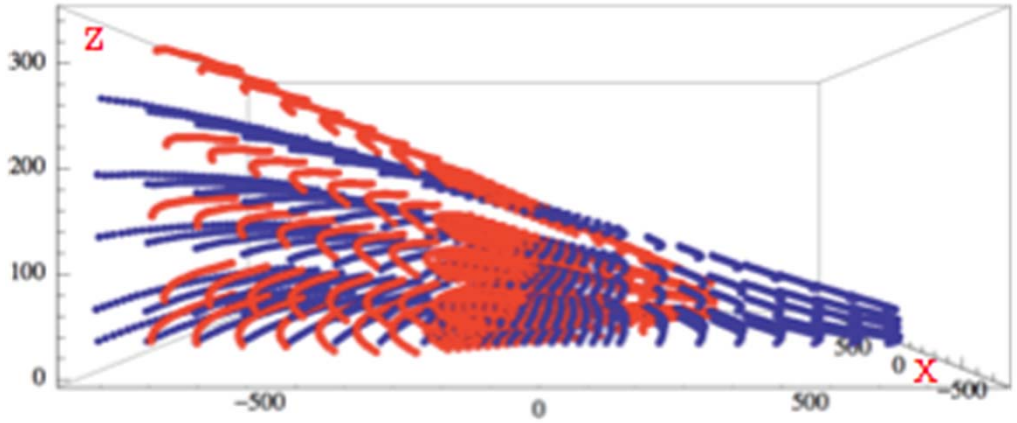


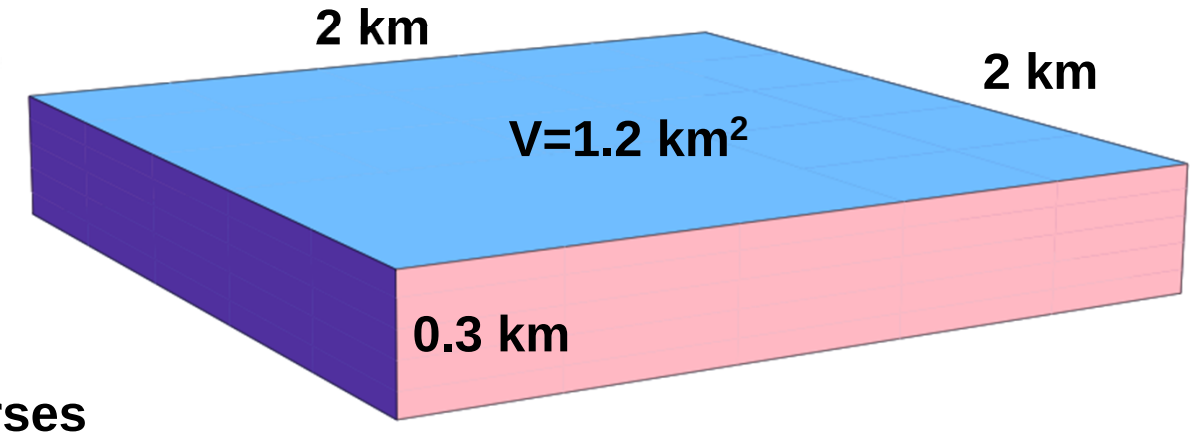
WindScanner 1 / WindScanner 2



WindScanner 1 / WindScanner 2

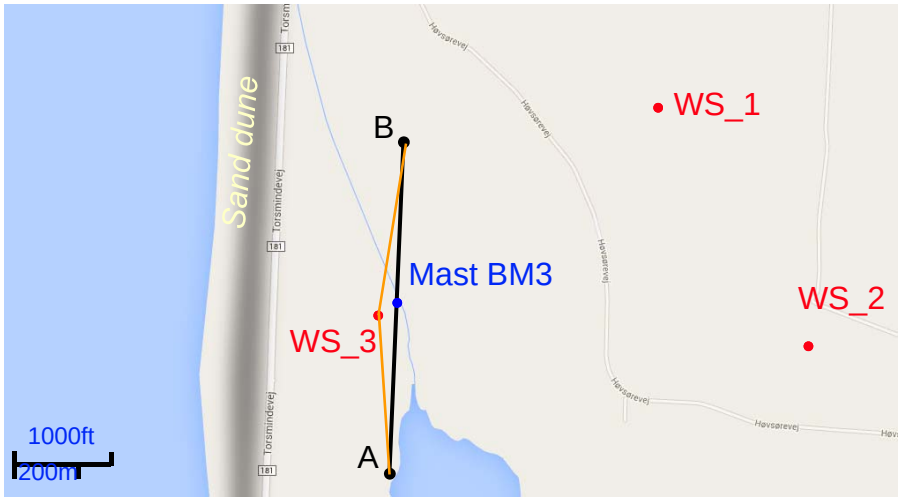


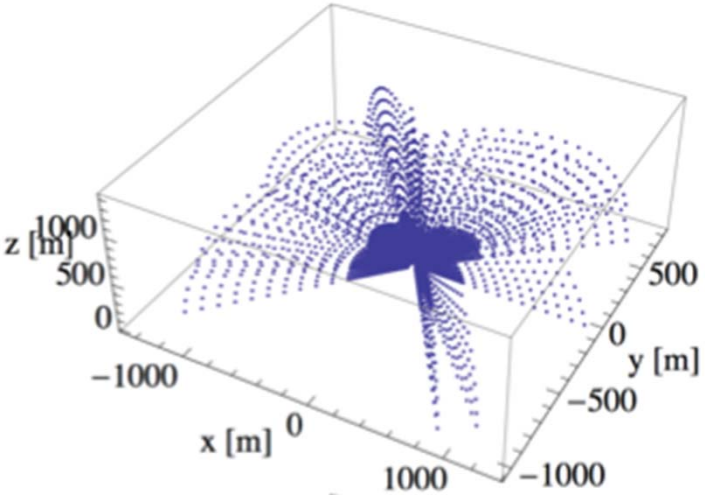


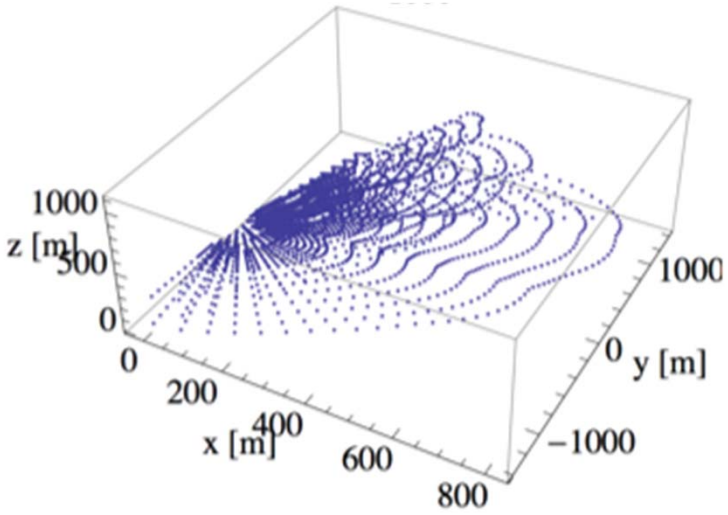


2*3000 radial velocities
60 seconds per volume
Synchronized along 5 traverses

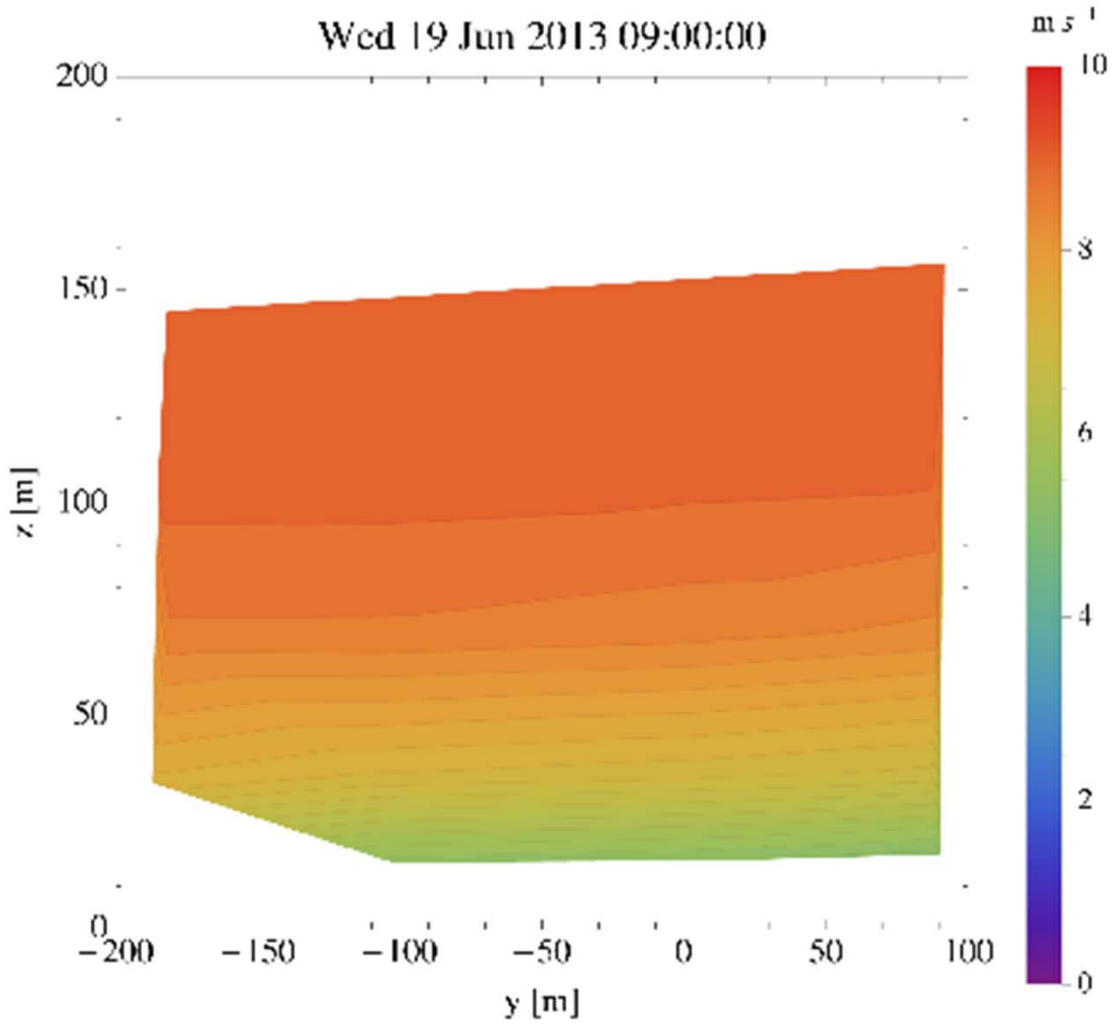
WindScanner 3







Results


Wed 19 Jun 2013 09:00:00
m s⁻¹
10
8
6
4
2
0
200
150
100
50
0
z [m]
−200
−150
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y [m]

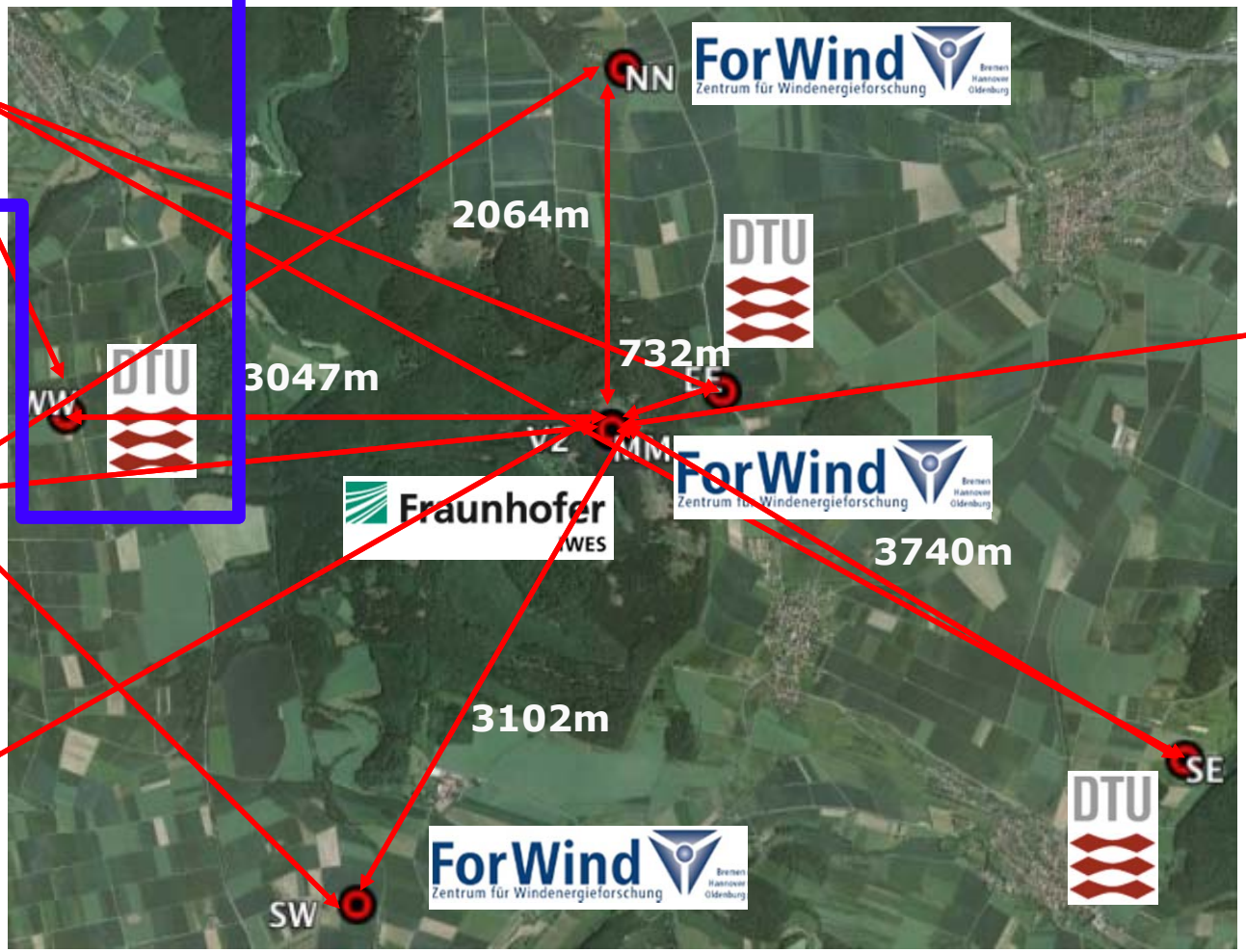
Kassel experiment

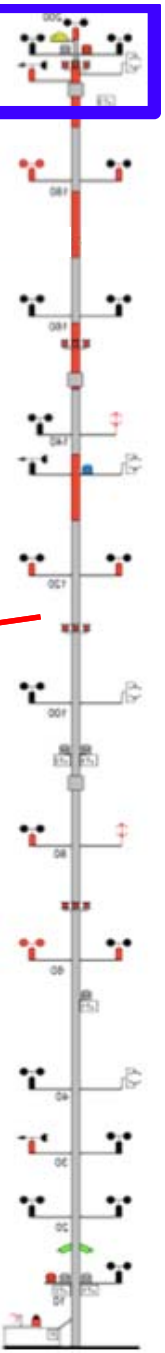
LRWS

Windcube 200S

Windcube V2

WindScanner vs. Sonic anemometer

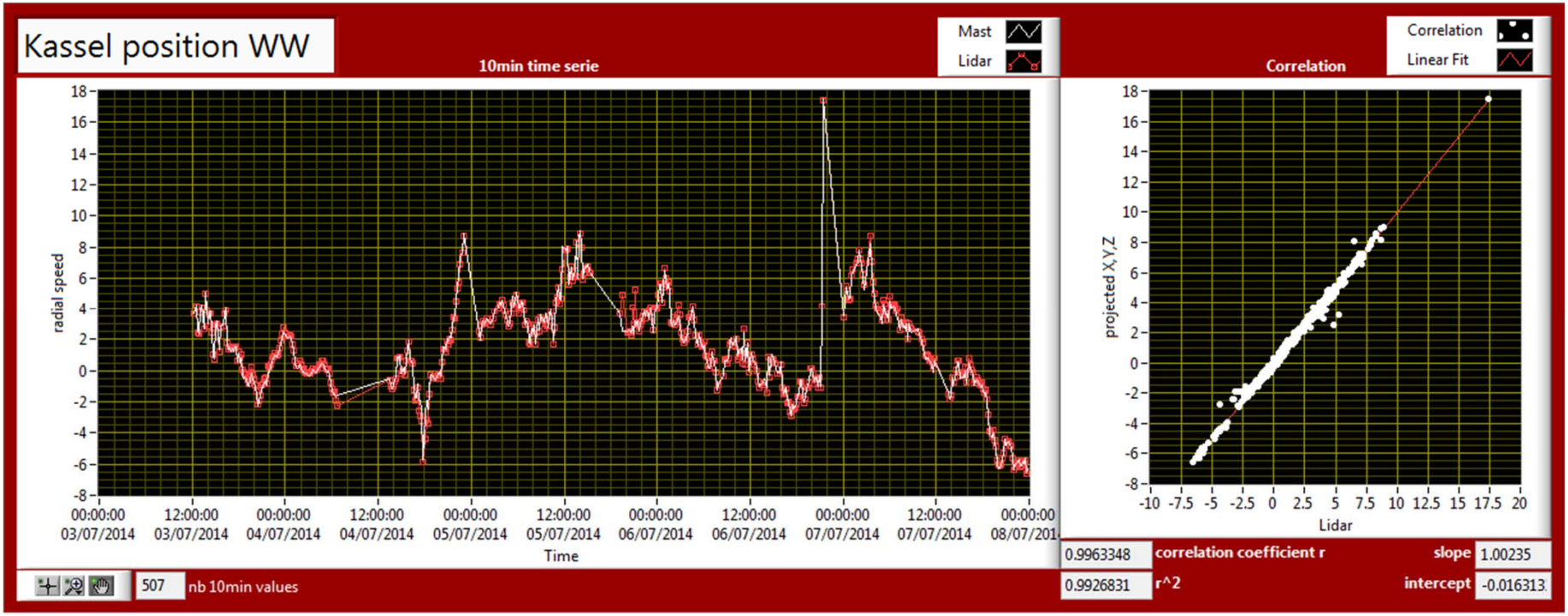




200m mast

Lidar at West position (WW):

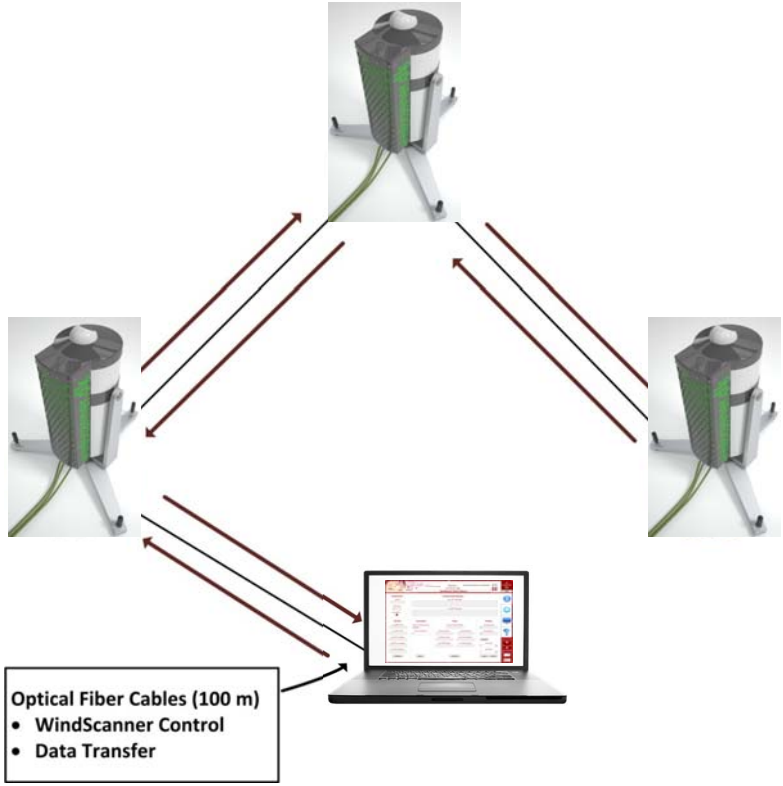
Azimuth: 90,99°
Elevation: 5,69°
Distance: 3102m



Laser beam pointing accuracy

Accuracy of 0.05°azimuth/elevation (1m over 1km)

Short-range WindScanner system



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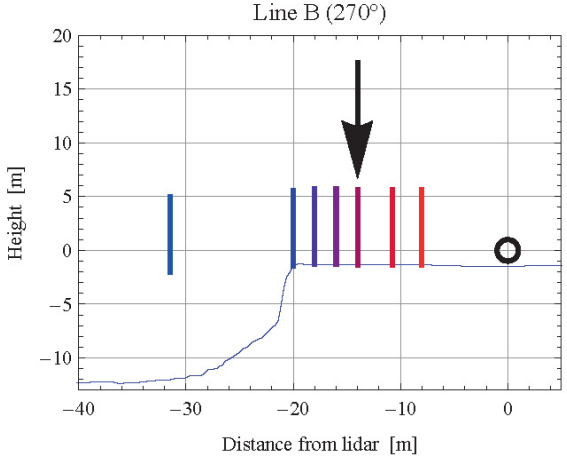
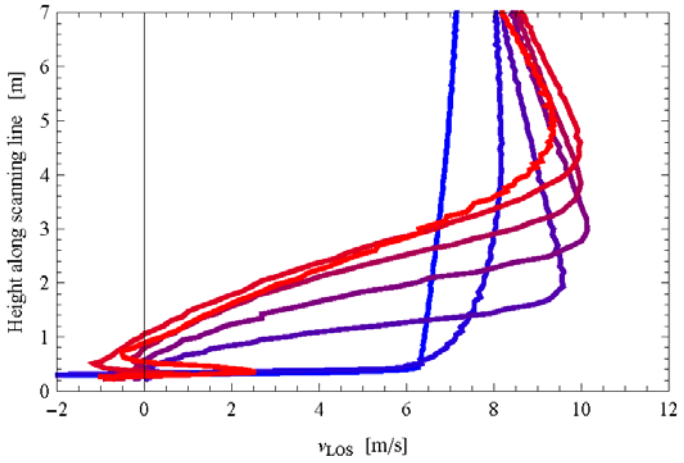
- WindScanners controlled via a near-by master computer
- Control achieved using network based on optical fibre cables
- WindScanners are synchronized
- Arbitrary scanning trajectories
- Appropriate for detail measurements in a small volume of interest

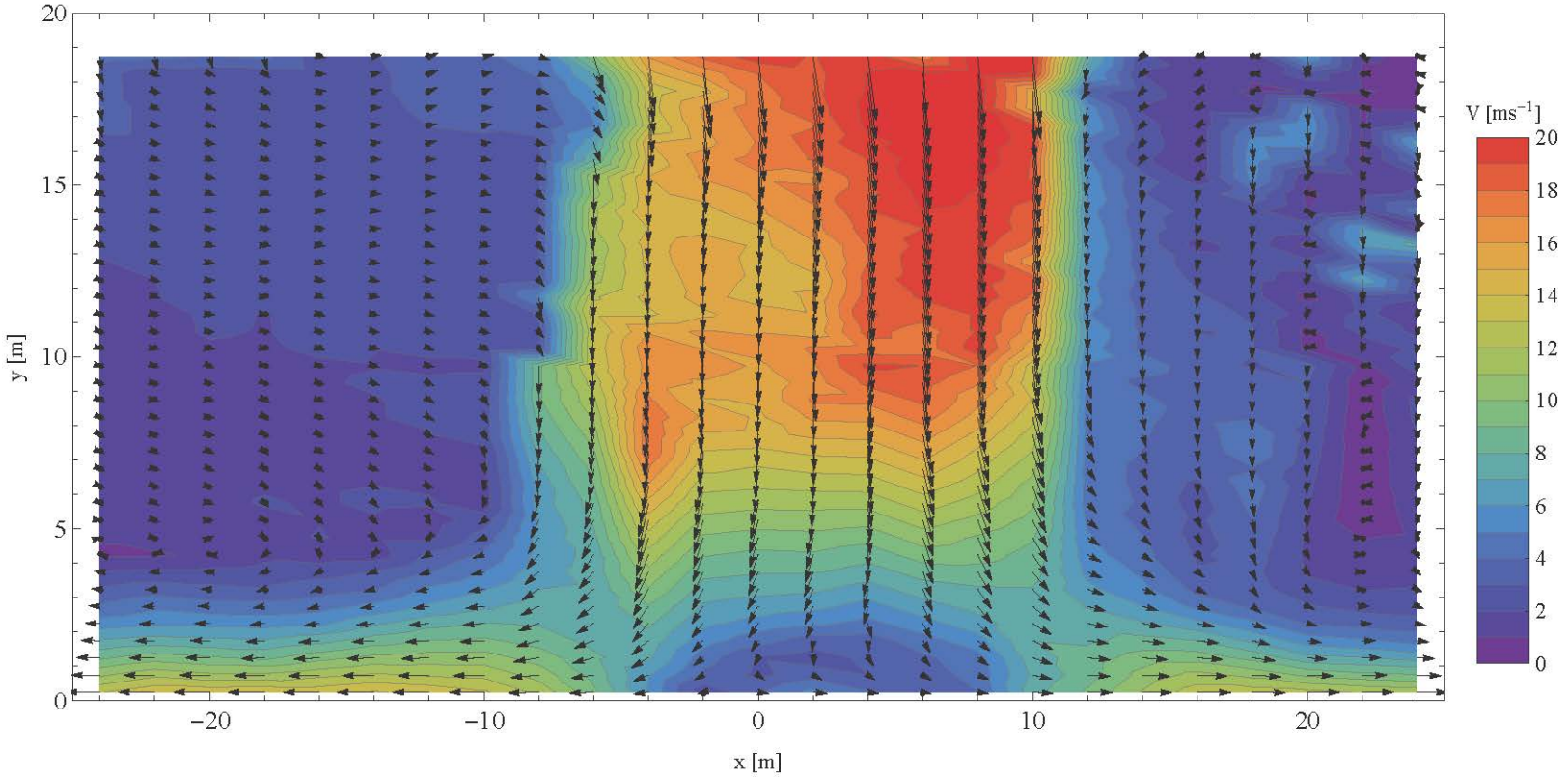
Applications

1. Laser scanning of a recirculation zone on the Bolund escarpment (Mann et. al, 2012)





Helicopter downwash: 2D vertical scan



Summary

- Two WindScanner system have been developed
- Two different lidar technology
- Two different approaches how we are forming the system
- Systems are complementary
- They have a great freedom in deployment
- They are flexible in terms of measurements scenarios
- They can provide synchronous 3D measurements of wind velocity fields

Thank you!

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